

ON *FIORIA VITIFOLIA* (L.) MATTEI\*

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## A B S T R A C T

In his revision of the genus *Hibiscus*, Hochreutiner (1900) included three species, *H. vitifolius* L., *H. dictyocarpus* (Hochst.) Webb. and *H. purpureus* Forsk. in section *Pterocarpus* Garcke. On the basis of the structural peculiarities of the 5-angular, alate, scarious, oligospermous capsules present in *H. vitifolius*, *H. dictyocarpus* and *H. pavonioides*, Mattei (1917) established a new genus *Fioria*. Although agreeing that the nature of the fruit in *Fioria* is strikingly different from that of any typical *Hibiscus* sp., Hochreutiner (1924) did not accept *Fioria* as a distinct genus. From his study of the conspicuous, scarious, strongly veined wings of *H. vitifolius*, Kearney (1955) justified the maintenance of *Fioria* as a distinct genus. Brenan and Exell (1958) did not accept it. In a detailed study of 80 specimens of *H. vitifolius* from different parts of India and abroad, several other distinguishing characteristics, in addition to those of the wings of fruit, have been observed, which justify retaining *Fioria* as a genus distinct from *Hibiscus*.

## INTRODUCTION

In his revision of the genus *Hibiscus*, three species *H. vitifolius* L., *H. dictyocarpus* (Hochst.) Webb. and *H. purpureus* Forsk. were included by Hochreutiner (1900) in section *Pterocarpus* Garcke. The main characters of the section are as follows: leaves palmati-lobed, margins serrated, tomentose or pilose; flowers with long peduncles, drooping; segments of epicalyx about 10, linear, shorter than calyx; calyx 5-lobed; petals 2 or 3 times longer than calyx; staminal column shorter than petals, antheriferous all through; fruits 5-winged, equal to or shorter than calyx. Of the three species

included in the section only *H. vitifolius* L. is found in India.

On the basis of the 5-angled, alate, scarious, oligospermous fruits present in the members of this section, Mattei (1917) raised this section to the status of a genus as *Fioria* and observed that it was intermediate between *Hibiscus* and *Kosteletzkya*, agreeing with the former in having several ovules in each locule of the ovary, (but occasionally reduced to one seed by abortion) and with the latter in having the carpels disarticulating at maturity. He summarized the characters of these related genera as follows:

- |  |     |                     |
|--|-----|---------------------|
| 1. Valves of the fruit not separating from the receptacle and forming a true capsule with polyspermous locules   | ... | <i>HIBISCUS</i>     |
| 1. Valves separating from the receptacle, not forming a true capsule, the locules oligospermous or monospermous (2)                                      | ... |                     |
| 2. Fruit not or scarcely depressed, glabrescent, the valves highly alate laterally, the locules oligospermous or rarely by abortion monospermous         | ... | <i>FIORIA</i>       |
| 2. Fruit strongly depressed-orbicular or 5-lobate, hispid at least on the angles, the valves not or only slightly alate, the locules always monospermous | ... | <i>KOSTELETZKYA</i> |

Of the three species included by Hochreutiner (1900) in section *Pterocarpus*, Mattei transferred only two of them to *Fioria* as *F. vitifolia* (L.) Mattei and *F. dictyocarpa*

(Hochst.) Mattei. He did not mention anything about *H. purpureus*, but included *Hibiscus pavonioides* as *Fioria pavonioides* (Fiori) Mattei.

\*Part of the work by the second author accepted for the degree of Ph. D. of Calcutta University.

Brenan and Exell (1958) have made a detailed study of *H. vitifolius* L. and basing mainly on trichome characters, distinguished *H. vitifolius* into two subspecies: subsp. *vitifolius* Brenan and Exell and subsp. *vulgaris* Brenan and Exell. They have not, however, recognised the genus *Fioria*.

In recent revision of the genus *Hibiscus*, Borssum-waalkes (1966) and Rakshit and Kundu (1970) have treated *H. vitifolius* under the section *Pterocarpus* Garcke.

*Hibiscus vitifolius* L. is widely distributed in tropical Asia, Africa and Australia and is also naturalized in several West Indian Islands, Cuba, Hispaniola, Jamaica, etc. and perhaps also in Central America. Materials of *Hibiscus vitifolius* have been collected from different parts of India, Burma, Ceylon, and Africa though it has not been possible to get any material from Australia and West Indian Islands.

In view of the uncertain position of the genus *Fioria* Mattei which has not been broadly accepted by several later workers, a detailed study of the species *Hibiscus vitifolius* was undertaken to find out whether it can be treated under a distinct genus, *Fioria* or kept as it is.

#### MATERIAL AND METHODS

Two sources of plant materials have been used: (1) fresh material from collections at the Jute Agricultural Research Institute, Barrackpore; Indian Botanic Garden, Howrah and Bally (near Bally Railway station) and (2) herbarium specimen obtained from different regional herbaria and the Central National Herbarium, Botanical Survey of India, Herbarium of the Forest Research Institute, Dehra Dun, Herbarium of the Dar es Salam University, Tanzania, and also herbarium specimens collected by the first author from Lucknow (India) and Sri Lanka. A list of the herbarium materials of *H. vitifolius* is given below. Herbarium specimens of fresh collections and permanent slide mounts of the studied materials are depo-

sited in the Central National Herbarium, Calcutta.

*Specimens examined*: A. Central National Herbarium, Howrah: I. INDIA. ANDAMANS: Mount Harriet, Kirat Ram, s. n. (acc. no. 66610). ANDHRA PRADESH: Peddakonda hill, Narayanaswamy 164; Cuddapah, Gamble 15135; Bisan hill, Godavari, Barber 5173; Ongole, Barber 7913; Balipalli, Gamble 16560; Godavari district, Ramaswami 1713. ASSAM: No locality, Jenkins s. n. (acc. no. 55148). GUJARAT: Gir hill, Mehta 1766; Gir forest, Raizada 21400; Sasan, Raizada 23718. KARNATAKA: North Canara, Talbot 894; Canara, Ahmad s. n. (acc. no. 89552). KERALA: Shencottah, Calder & Narayanaswamy 690; Waduvathumli, Calder & Narayanaswamy 122; Malayathur, Rama Rao 983. MADHYA PRADESH: Gwalior, Maries 46; Ambara range, Well 20. MAHARASHTRA: Bombay, Dalzell s. n. (acc. no. 55132). PANJAB: No locality, Aitchison 275-306. RAJASTHAN: Ajmer, Lowrie s. n.; Jodgarh, Merware, Lowrie 4525; Mount Abu, Duthie 6612. TAMIL NADU: Vellore, Barnes s. n. (acc. no. 112932); Coimbatore, Narayanaswamy 019175; Coimbatore, Fischer 445; Nilgiri hills, Schmid s. n. (acc. no. 55157); No locality, Krishnaswamy Naidoo s. n. (acc. no. 55158); Mertupalayam, Meebold 12027; Bodinaikonur, Meebold 13764; Shevani hills, Perrottet 278, 418; Kumul, Barber 8004; No locality, Ramaswami 330; Wight 190; Shuter s. n. (acc. no. 55172); Willdenow s. n. (acc. no. 55173). UTTAR PRADESH: Dehradun, Mackinnon s. n. (acc. no. 55736); Moradabad, Thomson 339; Raiwala, Dehradun, Harsikh s. n.; Dehradun, Duthie 1415; West Almora, Osmaston, 1533; Garwal, Gammie s. n.; Dadhuriya, Kheri district, Inayat 21602; Lucknow, Kundu 710. WEST BENGAL: Raneegunj, Kurz s. n. (acc. no. 55144); Sibpur, Kurz s. n. (acc. no. 55142); No locality, Kurz s. n. (acc. no. 55141, 46 & 47); Bally, Biswas 181; Barrackpore, Biswas, 47; Indian Botanic Gar-

den, Howrah, *Biswas* 76; Andul Road, *Kirat Ram* 13219. II. BANGLADESH: Jessore, *Clarke* s. n. (acc. no. 55145). III. PAKISTAN: Changa Manga, Lahore, *Parker* s. n. (acc. no. 40714). IV. BURMA: Prome, *Kurz* s. n. (Acc. no. 55185); *Wallich* 1899, 1900; Tobadowa, *Abdul Huk* s. n. (acc. no. 55181); Upper Burma, *Adbul Huk* s. n. (acc. no. 55182); Rangoon, *McLelland* s. n. (acc. no. 55183); No locality, *Shaik Moprim* 46, *Henderson* 2091. V. SAUDI ARABIA: *M. Deflers* s. n. (acc. no. 55814). B. Herbarium: University Dares Salam, Tanzania. I. EAST AFRICA: Tanga, *Archbold* 1435; Mbeya-Chunya, *Sturtz* 142. II. SRI LANKA: Mannar, *Kundu & Sadasivan* 810.

For the study of trichomes from fresh materials, scrapings or peelings were obtained from vegetative and reproductive parts of the plants and directly mounted in 50% glycerine. Whenever decolorization of the materials was necessary for observation, the samples were treated with rectified spirit and then cleared in satu. soln. of chloral hydrate or conc. lactic acid. For the study of venation and crystals from the lamina also the above methods have been followed.

In the case of dried herbarium specimens, for the study of trichomes, crystals, veins, fruit and seed, small pieces of materials were first boiled in water for two to three minutes and then boiled in 2.5% NaOH until the materials were decolorized. If decolorization did not take place with this method, the materials were washed in water repeatedly and then boiled in a mixture of  $H_2O_2$  and chloral hydrate (conc.) (1 : 1). It was again washed in water and then cleared in conc. lactic acid and mounted in fresh lactic acid. Permanent slides mounted in canada balsam were also prepared from part of the material treated above through dehydration and clearing. For the study of petiole vasculature serial sections of the node and basal, middle and distal portions of the petiole were cut and stained in IKI

soln. and 1% aqueous aniline blue. For anatomical study of the seed coat, sections of the seed coat were cut through the micropylar region. As lot of colouring matter is present, the sections, without staining, were passed through different alcohol grades and mounted in canada balsam. For cytological studies Beiling's (1926) method of acetocarmine staining was followed.

## OBSERVATIONS

### I. TRICHOMES

Generally in *Hibiscus vitifolius* L. several trichome types occur on all parts of the plant, though all types are not borne by a particular organ. A few of them, however, are strictly confined to certain parts. The trichomes represent the following types: [All measurements are in microns ( $\mu$ )].

(i) *Filiform-capitate* (Pl. 1.1): These trichomes are, long, multicellular and filiform, with a circular gland-like cap at their tip. Foot is simple and made up of one large bulbous cell and the body is differentiated into stalk and head. The basal portion of the stalk is mainly biseriate. The middle portion is generally uniseriate and at the top portion one or two anticlinal walls are occasionally found. The tip is formed of a head made up of two to four cells. The stalk cells are generally much longer than wide except for one or two cells at the tip. All the cross walls and the lateral walls are thin. The length and breadth of the trichomes are  $210\ \mu$ - $230\ \mu$  and  $15\ \mu$ - $20\ \mu$  respectively.

*Distribution*: All green parts, petals and capsules.

(ii) *Cylindrical-glandular* (Pl. 1.2): These trichomes are cylindrical, multicellular and uniseriate. Foot is simple and the body is entire. The basal body cell is rectangular in shape, and the length and breadth of cells at this region are more or less the same. The cells above this region are broader than they are long. The tip of the trichome is

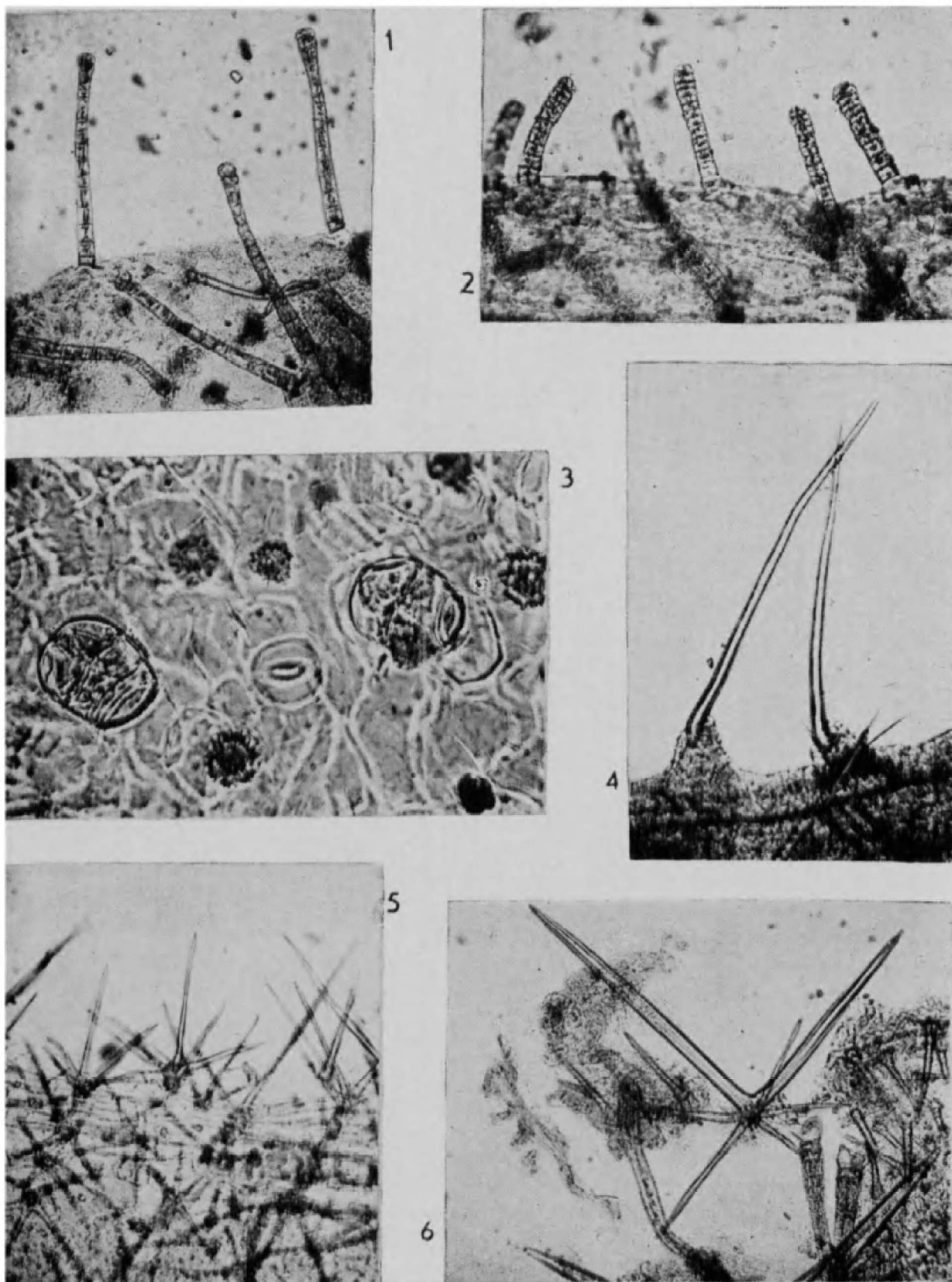


Plate I: Figs. 1-6 : Types of trichomes of *Fioria vitifolia* : 1. Filiform capitate. 2. Cylindrical glandular. 3. Club-shaped, head biseriate and spheroid. 4. Unicellular trichomes with multicellular cup at the base. 5. Stellate and thin-walled with short rays. 6. Stellate rays, both thick-walled and thin-walled.  
(1, 2, 5, 6  $\times 150$  ; 4  $\times 38$  ; 3  $\times 545$ )

more or less roundish and made up of many cells formed by anticlinal divisions. Length and breadth of the trichomes are  $120\mu$ - $130\mu$  and  $20\mu$ - $25\mu$  respectively.

*Distribution*: Adaxial surface of petal, especially over the upper half.

(iii) *Club-shaped, head biseriate and spheroid* (Pl. 1.3): These are the smallest type of glandular trichomes found in *H. vitifolius*. Foot is simple and unicellular. Body is differentiated into stalk and head. Two small cells form a short constricted stalk and the glandular head is made up of four to five rows of cells, in which the basal cells remain in two tiers and above them there is an apical cell, the tip of which is roundish to semi-roundish and the base is conical. The basal body cells are much broader than long and the walls are very thin. The length and breadth of the trichomes varies from  $30\mu$  to  $40\mu$  and  $20\mu$  to  $25\mu$  respectively.

*Distribution*: Most common, on all green parts and outer wall of the capsule.

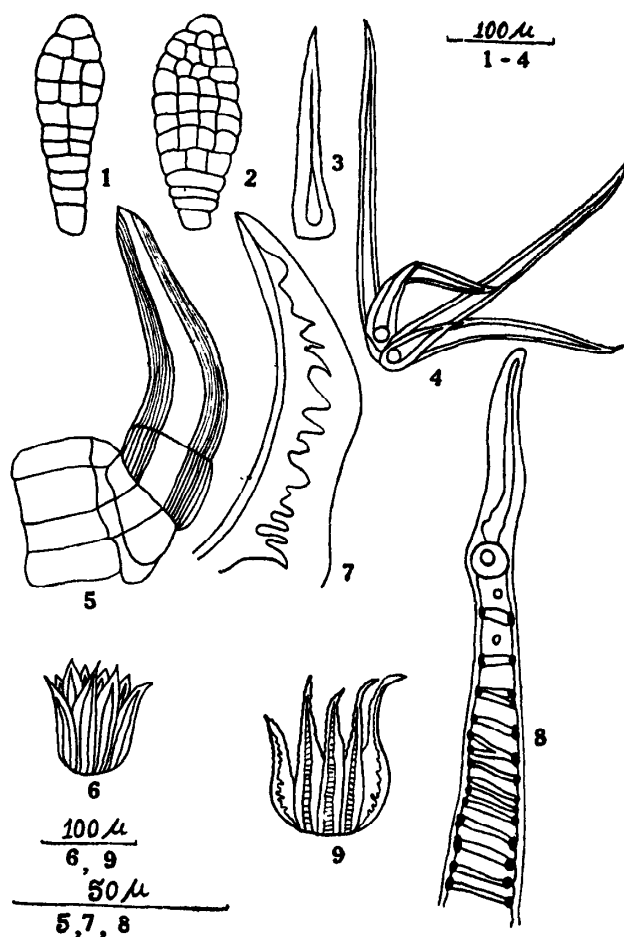
(iv) *Club-shaped and body spatulate*, (Fig. 1): The foot is simple and the body is multicellular, spatulate and is differentiated into stalk and head. The stalk is made up of three to four cells. The basal stalk cell is much longer than its width and the remaining cells are much broader than their length. The basal portion of the head consists of three tiers of biseriate cells. The middle portion is made of two tiers, each tier consisting of three cells. The maximum width of the trichome is noticed in this region. The tip is terminated by a semi-circular cell and below it two squarish cells are found. All the cross walls and lateral walls are thin and the cells are much broader than their length. Length and width of the trichomes are  $120\mu$ - $160\mu$  and  $32\mu$ - $48\mu$  respectively.

*Distribution*: Petals.

(v) *Club-shaped and body elliptic* (Fig. 2): The trichomes are multicellular, elliptical and without constriction at the stalk.

Foot is complex or rarely simple. Stalk is made up of three to four cells and the cells are much broader than their length. Head is multiserial, seven to nine cells in length and three to five cells in breadth and with a terminal semi-circular cell. The maximum width is noticed at the middle portion of the trichome. Most of the head cells are much longer than their width. All the cross walls and the lateral walls are thin. Length and breadth of the trichomes are  $112\mu$ - $192\mu$  and  $48\mu$ - $64\mu$  respectively.

*Distribution*: Staminal column.



Figs. 1-9. Types of trichomes found in *Fioria vitifolia*: 1. Club-shaped and body spatulate. 2. Club-shaped and body elliptic. 3. Unicellular with truncate base. 4. Stellate, thick-walled. 5. Aggregate with thick walls (single arm enlarged). 6. Aggregate with thick walls. 7-8. Aggregate with helical thickening. Lateral and dorsal views (single arm enlarged). 9. Aggregate with helical thickening.

(vi) *Unicellular trichomes with multicellular cup at the base* (Pl. 1.4): These trichomes are unicellular, round based and with pointed tip. These are generally developed from a multicellular cup like structure. The foot of the trichomes is complex. The body cell is always thick and sometimes, due to heavy thickening of the wall the lumen becomes very narrow. The tip is very much pointed and so stiff that it appears like a spine. Length and breadth of the trichomes are 3.5 mm and  $16\mu$ - $24\mu$  respectively.

*Distribution*: Quite common, on the stem, petiole and pedicel.

(vii) *Unicellular with truncate base* (Fig. 3): These trichomes are unicellular with flat base having a slight constriction a little above it and the tip is pointed or blunt. The foot is complex. The wall of the body cell is thick and sometimes the lumen has either disappeared or is found like a fine thread. Under high magnification the thick walls show the striations. Length and width of the trichomes are  $192\mu$ - $368\mu$  and  $8\mu$ - $16\mu$  respectively.

*Distribution*: On all green parts of the plants.

(viii) *Stellate and thin-walled with short rays* (Pl. 1.5): This type of trichomes are multicellular, with two to seven short rays of different length. The foot of the trichomes is complex and the body is entire. The short arms are radiating, from a common centre in different manners. Each arm is short, made up of single cell, thin-walled and sharply pointed. Lumen is prominent and distinct upto the tip. Length of the arms varies from  $50\mu$ - $200\mu$  and average width is  $10\mu$ .

*Distribution*: Stems.

(ix) *Stellate, thick-walled with very narrow lumen and with arms remaining in single group* (Fig. 4): These are also multicellular trichomes with radially projecting arms, just in a star-like manner. The num-

ber of arms varies from five to fifteen. The foot of the trichomes is complex and the body is differentiated into stalk and arms. Each arm is made up of only one cell. The wall is very thick and the lumen is distinguished upto two third length of the trichome. The walls of the arms are sub-rigid to rigid. The length of the arms varies from  $80\mu$  to  $280\mu$  and the breadth varies from  $12\mu$  to  $24\mu$ .

*Distribution*: Leaves, calyx and epicalyx.

(x) *Stellate-rays, both thick-walled and thin-walled* (Fig. 1.6): These trichomes are multicellular, the arms are radiating in all directions. Arms are made up of single cell, and the cell walls of the arms are either thick or thin. The foot is complex and there is no stalk. The total number of the arms varies from five to ten but the number of the thick-walled arms varies from three to eight. Here also the length of the trichomes varies very much i.e.,  $100\mu$ - $300\mu$  and average width is  $15\mu$ .

*Distribution*: Outer wall of capsule.

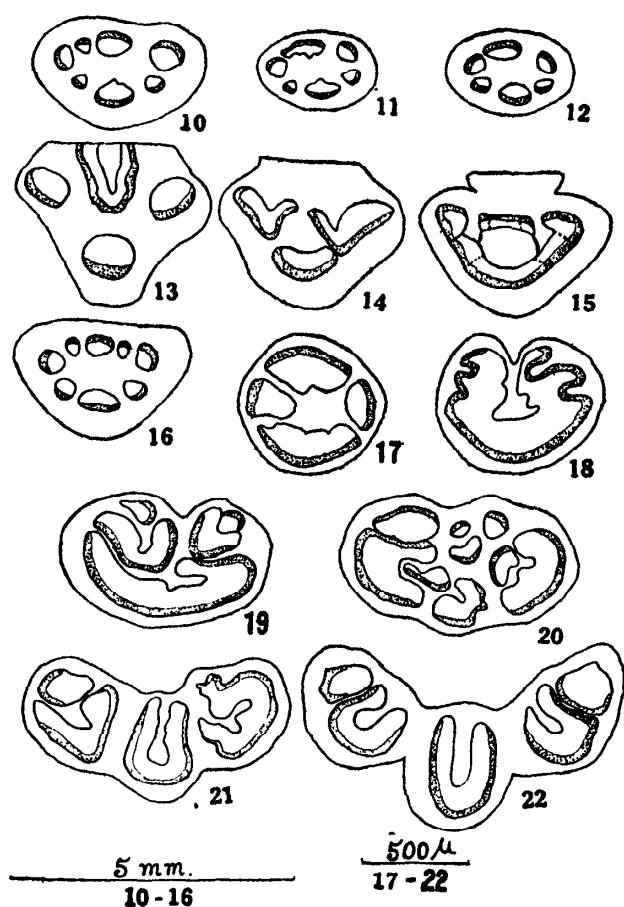
(xi) *Aggregated, very thick walled and lumen as thick as the cell-wall* (Fig. 5 & 6): Trichomes are multicellular, the arms are made up of three cells and they are radiating in all directions. The wall of the arm is very thick and straited and the lumen is very prominent and broad as much as the cell wall. The number of the arms varies from 8 to 12. The length of the arms varies from  $112\mu$  to  $130\mu$  and the width varies from  $21\mu$  to  $24.5\mu$ .

*Distribution*: Only seed coat.

(xii) *Aggregated trichomes with helical thickening* (Fig. 7-9): The trichomes are multicellular with 2-9 radially projecting arms. All the arms are directed in one direction. The foot of the trichome is simple. Each arm is unicellular. The wall of the arm is helically thickened; at the base of the arms the thickening is much more than at the tip portion. At the terminal portion this helical thickening is absent and a wavy

cylindrical thickening is found at the centre of the arm. The dorsal surface of the trichome is covered by a white matrix. The length and width of the trichomes vary from  $140\ \mu$  to  $245\ \mu$  and  $21\ \mu$  to  $24.5\ \mu$  respectively.

**Distribution:** Seed coat (only on material collected from Madras).



Figs. 10-22. T. S. of the petiole of *Fioria vitifolia*: 10. Base. 11. Middle. 12. Top. 13-16. T. S. of the base of the petiole showing development of vascular bundle of the same. 17-22. Sections of the top of the petiole showing change in the structure and arrangement of the vascular bundles.

## II. PETIOLE VASCULATURE

The vascular supply of the leaf is derived from three distinct and widely separated leaf traces (Fig. 13) accompanied by three gaps. The node is, therefore, trilacunar. The three leaf traces become completely separated from the stem stele as they pass through the en-

tire cortex and then unite forming an arc just below the abscission layer. From the lateral sides of the arc, that is, from each of the two lateral traces one large dissected vascular bundle separates towards the adaxial surface (Fig. 14) and moves just opposite to the median trace. These two bundles unite and form a median adaxial bundle (Fig. 15) from which two accessory bundles are later cut off on either side. At this stage one large semi-circular bundle is found on the abaxial surface of the petiole. From this large bundle, one abaxial median and two accessories (on either side of the median bundle) and at the extreme and two lateral bundles (one on either side) are developed. Therefore, in transverse section at the base of the petiole, a total of eight bundles are found in a semicircle (Fig. 16).

After approaching a short distance one of the adaxial accessory bundles joins with the adaxial median bundle and hence at about a centimeter above the base of the petiole the number of vascular bundles becomes seven (Fig. 10). But in the middle portion of the petiole the number of vascular bundle is six (Fig. 11) as the remaining adaxial accessory bundle also fuses with the main median adaxial bundle.

At the distal end of the petiole the number of vascular bundles remains six (Fig. 12), but 4 to 6 mm below the base of the lamina on the abaxial side the median bundle is fused with two accessory bundles; as a result, the number of vascular bundles at this position is four (Fig. 17). After approaching a very short distance all the four bundles unite to form an open ring towards the adaxial surface. Both ends of the ring are outwardly curved and the whole vascular bundle becomes five-lobed (Fig. 18). This five-lobed bundle is broken into two small, two median and one large bundle (Fig. 19). In the next stage the large bundle is also divided into four to five bundles and the disposition of the bundles is also changed

here (Fig. 20). The small bundles join the large ones becoming horse-shoe shaped and the newly formed bundles are arranged towards the abaxial surface of the petiole (Fig. 21). At first three large horse-shoe shaped bundles are found and later the lateral bundles cut off two small bundles at their extreme ends. Therefore, at the base of the lamina five vascular bundles are found (Fig. 22).

### III. CRYSTALS

On examination of hand sections of the lamina under the polarizing microscope in dark field illumination, the extinction of light effect at a particular angle proves the presence of crystalline body within the section (Pl. 2.8). Under the light microscope and the phase contrast microscope these crystalline structures are smooth and polyhedral (Pl. 2.7). Under the polarizing microscope these crystals show various colours at different angles and hence it proves that the crystals are anisotropic in nature.

In free hand sections, when a few drops of HCl are applied, after a few seconds the crystals are dissolved and effervescence is noticed, proving that the dissolved materials are crystalline in nature. Calcium oxalate is tested in the following (Pizzolato, 1964) methods. First the sections are placed on a slide, then a few drops of 30% hydrogen peroxide and 5% silver nitrate (1:1) are added on the slide and the slide is kept near the fluorescent lamp for 15-30 minutes. A black precipitate is found upon the crystals.

Generally two main groups of crystals are observed. The aggregations of microcrystals are found through a central core. But in the examined material, this core appears like a straight line at the central portion of the large crystals (Pl. 2.9).

(i) *Lamellar aggregation*: When each and every crystal in the aggregates is plate or leaf-like, the structure of the crystal is lamellar. The varieties of the grains or crystals are distinct and hence they are grouped

under the 'phaenerocrystalline' form. Six or eight individual plates remain at  $45^\circ$  or  $40^\circ$  angles respectively (Pl. 2.7). The length and width of the crystal vary from  $24\ \mu$  to  $48\ \mu$  ( $40\ \mu$ ) and  $32\ \mu$  to  $48\ \mu$  ( $40\ \mu$ ) respectively.

(ii) *Granular aggregation*: The fine granular individual crystals differ much in size, but each and every variety is not discernible. Therefore, this type of aggregation remains under the head of 'cryptocrystalline' form. When the individuals aggregate, a definite angle cannot be found in between any two individual crystals. Most of the authors described this type of aggregated crystals as 'druses'. The diameter of this aggregation varies from  $8\ \mu$  to  $24\ \mu$  ( $18\ \mu$ ).

The lamellar aggregations are generally observed within the lamina, specially in palisade and spongy cells, but in other tissues, these are less frequent. These crystals are found within the vein islets and some of them are associated with the vein endings. The number of these crystals per vein islet generally varies from 0 to 2 (Pl. 2.9). But the granular aggregations of smaller crystals are commonly associated with all sides of the main veins. In these the number of crystals is however too great to count.

### IV. VENATION PATTERN OF LEAVES

The main vein type is 'actinodromous', (Hickey, 1973) that is, three or more primary veins diverge radially from a single point and the secondary veins are generally lacking in the admedial sides of the first two primaries (Pl. 2.10). The total number of primary veins ( $1^\circ$ ) is five or rarely seven and originate from the base of the leaf; therefore, the primary vein radiation is basal. The development of primary veins is perfect and marginal; width of vein size is weak (1.25%) and the course is sinuous.

The angle of divergence of the secondary veins ( $2^\circ$ ) is acute and wide ( $\angle 65^\circ$ - $\angle 80^\circ$ ) and the variations in angle of divergence is nearly uniform. Relative thickness of secon-

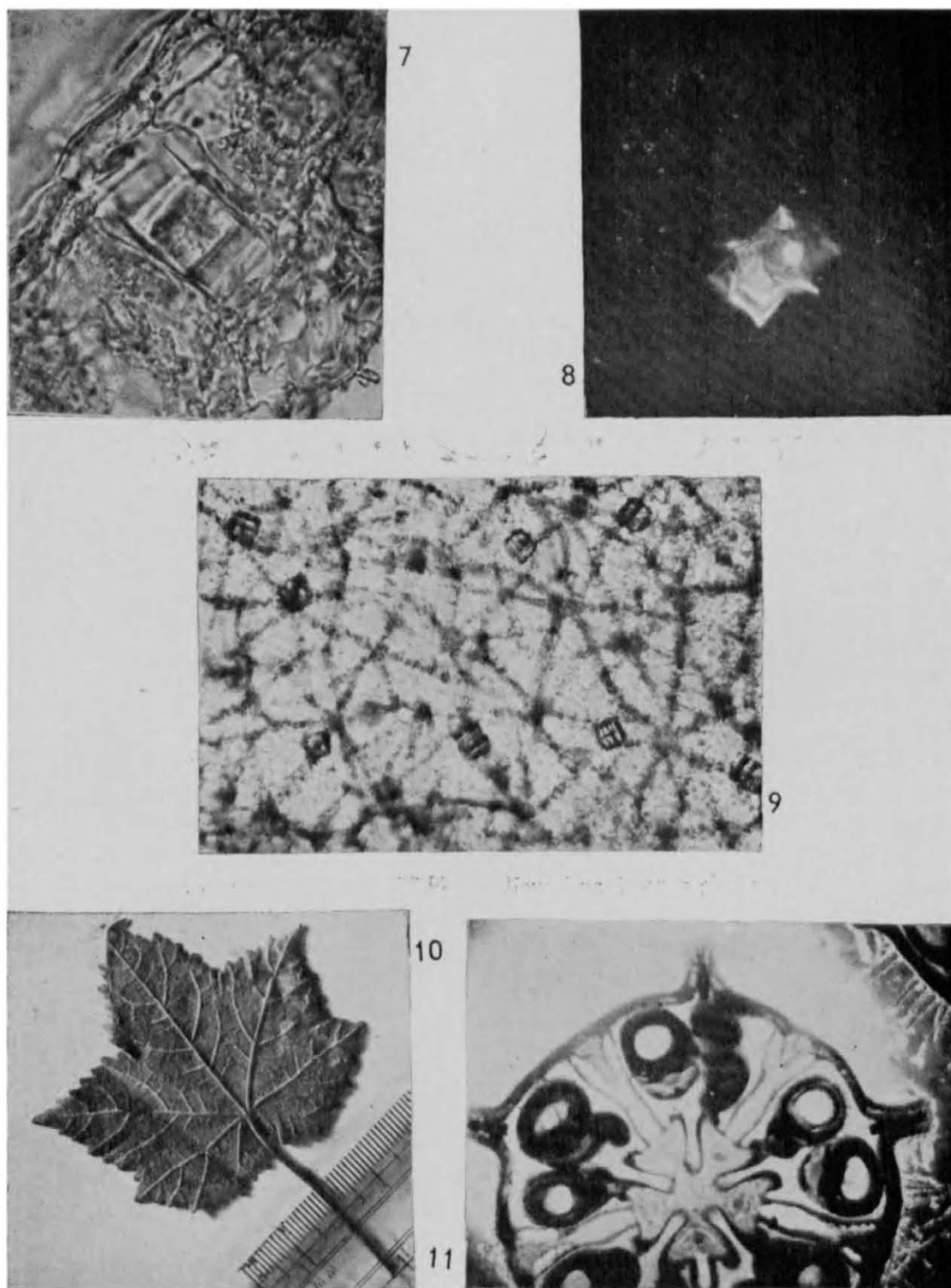


Plate II: Figs. 7-11 : 7. Phase contrast micrograph of crystal in the T. S. of lamina of *Fioria vitifolia*. 8. Crystal seen in the polarized light. 9. Distribution of the crystal in the lamina. 10. Venation of the leaf. 11. T. S. of the young fruit.  
(7, 8×700; 9×150; 11×38).

dary veins is moderate, *i.e.* proportionately reduced and their course is abruptly curved. Inter-secondary veins are present and are of composite type. The number of marginal teeth per secondary vein varies from 1 to 3.

The angle of divergence of the tertiary veins ( $3^\circ$ ) is acute and acute (AA) and their pattern of distribution is percurrent that is, the tertiaries are arranged between two opposite secondaries or between a primary and a secondary; course is sinuous and convex and arrangement of the veins is predominantly alternate.

The size of the quaternary veins ( $4^\circ$ ) is proportionately reduced and their course is orthogonal, that is, arising at right angles with the tertiary.

The quinary vein ( $5^\circ$ ) size is also proportionately reduced and its course is similarly orthogonal.

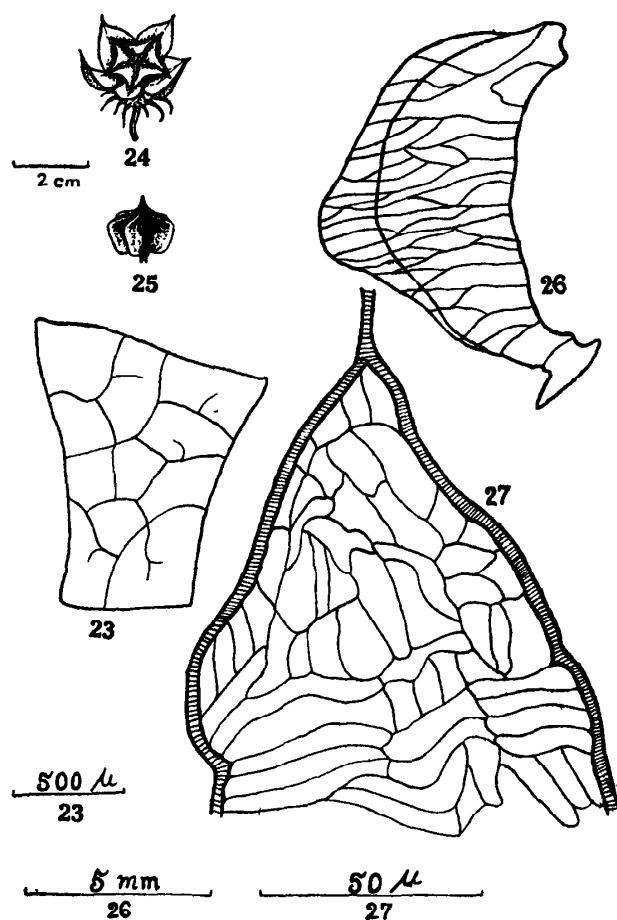
The marginal ultimate venation is incomplete. Various types of veinlets per vein islets are usually found (Fig. 23). The percentage of types of veinlets is none (that is, vein-islets without any veinlets) 57%, simple (that is, vein-islets with only one vein-islet) 37.5% and branched (that is, vein-islets giving rise to ramifications by dichotomising) 5.5%.

The arcoles are small (0.3 mm) and well developed and randomly arranged with irregular shapes. The average numbers of vein-islets and vein endings per square mm are 29.87 and 17.37 respectively.

#### V. FRUIT STRUCTURE

The fruit is a globular, depressed, beaked, hairy capsule, shorter than the calyx, 5-valved and winged at the dorsal edge (Pl. 2.11). During dehiscence, the wings briskly split laterally on the keels (Figs. 24, 25).

The skeleton of the wing is made up of two strong veins running vertically throughout its margin. In transverse section of the wing, there are many minor veins which form a strong net-like structure. Within the netted veins, many large more or less rect-



Figs. 23-27 : 23. Vein islets and types of vein endings. 24-27. Fruit of *Fioria vitifolia* : 24. Top view. 25. Lateral view. 26. Skeleton of the wing. 27. Enlarged portion of wing showing the arrangement of parenchymatous cells.

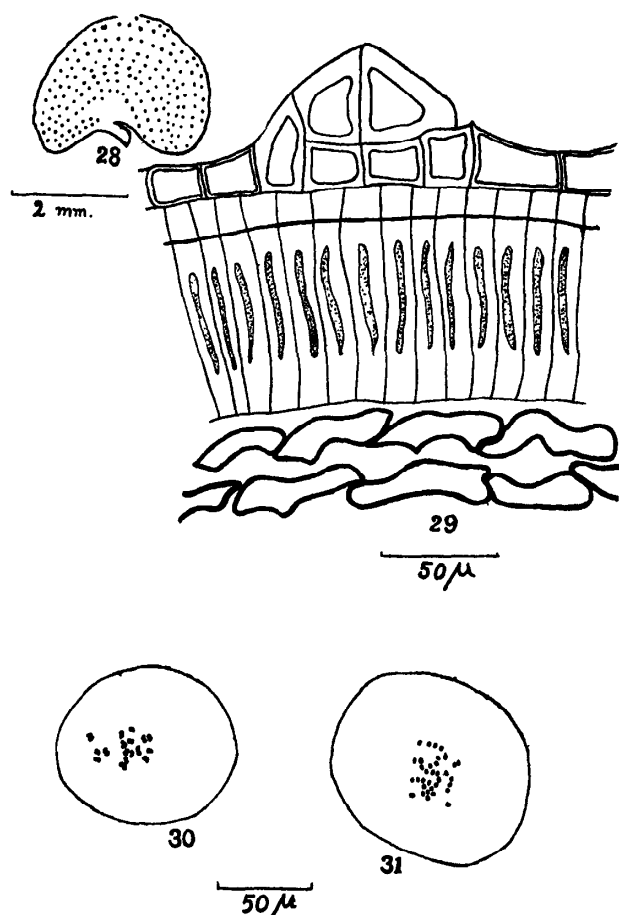
angular parenchymatous cells, are present. These parenchymatous cells are arranged in two distinct groups, one group remaining at right angle to the other (Fig. 27).

#### VI. SEEDS

The seeds are kidney-shaped, few seeds (3-5) are present in each locus; short aggregated hairs looking like small warts under low power magnification are observed and they are arranged in concentric rings. In the micropylar region, these warts are arranged very closely (Fig. 28).

In transverse section of the seed coat (Fig. 29), a single layer of parenchymatous cells fairly regular in outline, is seen. Groups of very thick-walled epidermal hairs within cup-like structures are present. Below the

epidermis a single layer of very long palisade cells is found, with yellow coloured contents in their middle. A conspicuous long light line is found in the palisade cells, just below the epidermis. Striations are usually found in the walls of palisade cells. Next to the palisade layer, a deep brown-pigmented parenchymatous tissue is found which is several layers in thickness.



Figs. 28-31 : 28. Seed of *Fioria vitifolia*. 29. T. S. of the seed coat. 30-31. Meiosis of *Fioria vitifolia* : 30. Showing 17 bivalents in pollen mother cell. 31. Showing 34 bivalents in pollen mother cell.

#### VII. CYTOLOGY

The chromosome number of *H. vitifolius* has been observed to be  $n=17$  (Fig. 30); but in one pollen mother cell a variable number,  $n=34$  (Fig. 31) has also been seen. Skovsted (1935) reported the chromosome number of this species as  $2n=34$  and  $2n=34+0-1B$ . The chromosome number of

different species of *Hibiscus* varies very much, but in maximum number of species the chromosome number is  $2n=72$ . (Federov, 1969). In *Abelmoschus* spp. also the chromosome number varies very much being  $2n=72$  to 132. In *Kosteletzkya*, the position of which is between *Hibiscus* and *Abelmoschus*,  $2n$  chromosome number is 34. It is, therefore, felt that *H. vitifolius*, should be treated separately and have a position near *Kosteletzkya*. But since the karyotype is not known, definite conclusion from cytological view point cannot be drawn.

#### DISCUSSION

On the basis of the foregoing morphological and anatomical observations of different parts some characters have been found, which are altogether absent in the other species of *Hibiscus*. Twelve types of trichomes have been observed in *H. vitifolius* and among them seven types, (1) filiform capitate, (2) cylindrical glandular, (3) club-shaped with elliptic body, (4) unicellular with truncate base, (5) stellate rays both thick-walled and thin-walled, (6) aggregate rays, with lumen as thick as cell wall and (7) aggregated hairs with helical thickening, are absolutely restricted to the different parts of this species and are not found in any other species of *Hibiscus*. Metcalfe and Chalk (1950) recorded peltate hairs in *Hibiscus* spp., but such a type is absent in *H. vitifolius*. They also recorded in *Hibiscus* spp. multicellular capitate glandular hairs of various sizes and shapes and smaller glandular hairs, composed of fewer cells; these types have been observed in *H. vitifolius*. Molby (1931) reported stellate and aggregated hairs in *Hibiscus* which have also been observed in this species.

The trilacunar node is the usual character of the genus *Hibiscus* (Howard, 1962) as also of other genera of the family Malvaceae, (Metcalfe and Chalk, 1950). At the base of the petiole of *H. vitifolius*, one large adaxial bundle is found, but in *H. sabdariffa* and

*H. cannabinus* instead of one, two large adaxial bundles are found, so the total number of vascular bundles varies from species to species (Biswas, 1974). But the number of vascular bundles at the middle and at the top of the petiole is similar to other species of *Hibiscus* (Petit, 1887; Biswas, 1974). At the junction of the petiolar top and the leaf blade, the changes (transition) of the vascular bundles is a characteristic feature in these species. The positional changes of the vascular bundles have taken place by the fusion of abaxial median with its accessory and then with their corresponding lateral bundles. Now the large fused bundle divides into five segments. At first, the smaller bundles join with median bundle and the three large horse-shoe shaped bundles are oriented on the adaxial surface. From this stage 5, 7 or 9 vascular bundles are given off from the lateral bundles corresponding to the number of primary veins present in each leaf (Watari, 1934).

In the lamina of *H. vitifolius* both lamellar and granular crystal aggregates have been noted. But in other species of *Hibiscus* only granular crystal aggregates, the druses type, are found in the lamina. On the other hand, in the species of *Abelmoschus* the lamellar aggregations are very common in the lamina. Al-Rais, *et al.* (1971) showed correlation between the morphology of crystal and the degree of hydration of the calcium oxalate crystals. Scurfield, *et al.* (1973) state that the presence of impurities in the crystal is the rule and the types of impurities vary from species to species. So, the morphology of the crystal depends upon its total chemical composition. Therefore, the morphology of crystals in *H. vitifolius* is very different from that in other species of *Hibiscus* and *Abelmoschus*.

The main vein pattern of *H. vitifolius* is actinodromous which is similar to that in other species of *Hibiscus* (Biswas, 1974). But the higher order venation, that is, areoles,

vein islets and vein ending number per square mm, is completely different from that in other species of *Hibiscus*.

The structure and texture of the 5-valved fruit of *H. vitifolius*, which is winged at the dorsal edge, are markedly different from those of other species of *Hibiscus*. In *H. dictyocarpus* (Hochst.) Webb., the capsule is also 5-valved and winged at the dorsal edge and hence Mattei (1917) transferred it to *Fioria*, as *F. dictyocarpa* (Hochst.) Mattei.

The wings of the fruits were considered by Mattei (1917) as aids to disseminate by wind. Hochreutiner (1900) in his first work on *Hibiscus* failed to define the function of the wings of the fruits and he thought that these organs were useless as flight devices because they were placed on the dorsal side of the mericarps which open out to liberate the seeds. These arguments were criticised by Mattei (1917). According to him, if two lobes of the fruit open, the three others remain closed and these would take advantage of the fruit wings for the dissemination of the seeds by the wind. Hochreutiner (1924) did not accept this explanation which according to him seemed to be impossible, because he had seen very frequently a general dehiscence of all the lobes and not of two lobes only as stated by Mattei.

Whatever the biological function, if any, of the wings may be, the structure and the texture of the fruit in *Fioria* (*Hibiscus* spp. of section *Pterocarpus* Garcke) is strikingly different from those typical of *Hibiscus*. Kearney (1955), from his study of the conspicuous scarious, strongly veined wings of *H. vitifolius*, justified the maintenance of *Fioria* as a distinct genus.

On the basis of fruit characters, Mattei (1917) described the three species of the section *Pterocarpus* of Hochreutiner as *F. vitifolia*, *F. pavonioides* and *F. dictyocarpa*. He further subdivided *F. vitifolia* into seven sub-species mainly on the basis of stem prickles and the shape of the calyx lobes.

We examined many materials collected from different ecological regions of India and also from Ceylon, Arabia and Africa, but did not find any prickles on the stem or any other part. The presence of prickles in *H. vitifolius* was also mentioned by Oliver (1868) and Borssum-Waalkes (1966), according to whom the number of prickles is variable even in the same plant. It is, therefore, not desirable to distinguish varieties on the presence or absence of prickles. The shape of the calyx as described by Mattei (1917) appears to be rather vague, as in the same specimen both lanceolate and ovate calyx-lobes were observed; besides, the calyx lobes, lanceolate in the flowering condition, often become ovate in the fruiting condition. For this reason, it has not been possible to split up the species into different varieties on the basis of the structure of the calyx-lobes, as done by Mattei (1917).

On the basis of the density of the indumentum upon the leaves, Brenan and Exell (1958) divided *Hibiscus vitifolius* into two sub-species, subsp. *vitifolius* and subsp. *vulgaris*. But due to variation in ecological conditions the trichome types vary from part to part and the density of trichomes also varies in the same plant (Biswas, 1974). Borssum-Waalkes (1966) also states that 'in sunny places the indumentum is usually denser than in the shade, where completely glabrous specimens may be found'. In view of these, it is not possible to distinguish this species into different sub-species or varieties even on the basis of the density of the indumentum of the leaves.

From the foregoing observations and distinguishing characters it is felt that *Fioria* Mattei may be justified as a genus distinct from *Hibiscus* L. It has also been observed that *Fioria vitifolia* is a very variable species and its splitting into two sub-species (Brenan and Exell, 1958) or seven varieties (Mattei, 1917) is not possible. We may end by quoting the remarks of Wight and

Arnott (1834): "so endless are the forms of leaves of this plant that we dare not characterise varieties."

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